Sensitivity Of Quake3 Players To Network Latency and Jitter

An incomplete, experimental look at the impact of network conditions on a player's choice of server for multiplayer, networked games

(Oh, and something fun to do as well....)

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Introduction

- Qualitative assertion: Low latency and jitter are desirable for real-time, interactive games
- Quantitative assessments: Rare, yet useful to ISPs and game hosting companies
  - What is the latency radius within which I'll find my primary population of players?
- This project attempts to correlate observed player activity with network conditions
  - Specific context: Quake III Arena, a networked, multiplayer 'first person shooter' (FPS) game
- Hope others will embark on similar research
  - This project is self-funded, donated resources
Test Environment

Hypothesis:

- Players will prefer lower 'ping' times to servers
- Server usage patterns will reflect topological locality of players

Methodology:

- Establish two QuakeIII servers that appear identical to client-side selection process
- Log players, their IP addresses, and in-game 'ping' samples over period of months
- Assess topological locality of players, and distribution of observed ping values.

Reality:

- **Californian server:** 600MHz Celeron, 128MB, FreeBSD4.2, T1 link to PAIX (hosted in Palo Alto)
- **London server:** 900MHz Athlon, 128MB, Linux kernel 2.4.2, 10Mb link to UK net (hosted at University College London)
- **Both servers advertised their location as "Palo Alto, California"**
Quick Stats....

Duration of Trials:
- **Californian server:**
  May 17 to Aug 18, 2001
  5290 unique clients
  338 clients played >= 2hrs each
  164 'days' aggregate played time
- **London server:**
  May 29 to Sep 12, 2001
  4232 unique clients
  131 clients played >= 2hrs each
  77 'days' aggregate played time

Common server details:
- Quake III version 1.17 (linux binary)
- Same 6 maps, fixed cycle sequence
- 20 minutes per map
- Up to 6 remote players
- 2 permanent 'bots' to attract players
- Identical registration with master server (clients see latency as only difference)
- Server-side 'ping' sampled everytime player runs over an object, dies, or kills another player

Donated resources:
- Tristan Henderson supported server at UCL
- Brian Reid supported server in Palo Alto
Popular Latencies

Median 'ping' per game:
- Each player's 'ping' sampled > 10 times per game
- Median values per player per game
- Cumulative plot reflects most frequently appearing median ping values
- California and London curves similar

Players who picked up at least 1 item per minute (minimal activity)
- California 1: 80% < ~196ms
- London 1: 80% < ~210ms

Players who picked up at least 10 items per minute (reasonably active)
- California 10: 80% < ~158ms
- London 10: 80% < ~182ms

But what does this prove?
- Perhaps nothing!
  • Perhaps nothing!
  • Need evidence of regional locality...

Cumulative Median Ping

Players who picked up at least 10 items per minute (reasonably active)
Evidence of Locality #1

Cyclical usage patterns:

- Usage patterns peak at different times, different demographics
- Peaks reflect afternoon and evening of their respective locations
  - London 8 hours ahead of Palo Alto
- Servers attract regional players
  - Supports hypothesis that clients prefer 'closer' server, other things being equal
Evidence of Locality #2

The Origin of Players:

- Based on reverse lookups on each player's IP address:
  - Californian server: mostly North America
  - London server: mostly Europe and US East Coast

- Since each server was otherwise identical, latency seems plausible as the client-observable metric on which a player chooses their server.

Using active players who picked up at least 10 items per minute during each game:

<table>
<thead>
<tr>
<th>Rank</th>
<th>Californian Games/Time(min)</th>
<th>Californian Origin</th>
<th>London Games/Time</th>
<th>London Origin</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>323 / 3005</td>
<td>.ed.shawcable.net</td>
<td>108 / 1027</td>
<td>.pit.adelphia.net</td>
</tr>
<tr>
<td>2</td>
<td>192 / 2072</td>
<td>.cruzio.com</td>
<td>73 / 690</td>
<td>.Uni-Mainz.DE</td>
</tr>
<tr>
<td>3</td>
<td>124 / 1383</td>
<td>(RogersEAST/@Home)</td>
<td>75 / 679</td>
<td>.upc-d.chello.nl</td>
</tr>
<tr>
<td>4</td>
<td>119 / 1246</td>
<td>.018.popsite.net</td>
<td>50 / 606</td>
<td>(telnordia.se)</td>
</tr>
<tr>
<td>5</td>
<td>118 / 1221</td>
<td>.tx.home.com</td>
<td>53 / 604</td>
<td>.dyn.optonline.net</td>
</tr>
<tr>
<td>6</td>
<td>150 / 1200</td>
<td>.mediaone.net</td>
<td>44 / 565</td>
<td>(Rogers EAST/@Home)</td>
</tr>
<tr>
<td>7</td>
<td>132 / 1178</td>
<td>.pit.adelphia.net</td>
<td>35 / 463</td>
<td>.dyn.optonline.net</td>
</tr>
<tr>
<td>8</td>
<td>115 / 1151</td>
<td>.socal.rr.com</td>
<td>53 / 448</td>
<td>.dialup.tiscaliinet.it</td>
</tr>
<tr>
<td>9</td>
<td>87 / 980</td>
<td>.pa.home.com</td>
<td>34 / 430</td>
<td>.pa.home.com</td>
</tr>
<tr>
<td>10</td>
<td>93 / 938</td>
<td>.sfba.home.com</td>
<td>20 / 288</td>
<td>.tx.home.com</td>
</tr>
<tr>
<td>11</td>
<td>69 / 799</td>
<td>.hsia.telus.net</td>
<td>24 / 273</td>
<td>.btinternet.com</td>
</tr>
</tbody>
</table>

() bracketed origins involved looking up 'whois' database after .in-addr.arpa failed.

Table above shows origins of top 11 players on each server. Outside the top 11, the Californian server also saw dedicated players from ".jp" while the London server saw dedicated ".nl" and ".uk" players. There is also cross-over by players equidistant from either server.
The aim is *fragging*
there is no other reason to play...

- Skill and response time
  influence a player's ability to
  frag (kill) others in the game
  - Response time has human and
    network components

- Average frag rate vs median
  ping hints at the negative
  impact of high latency
  - A player with 45ms ping could
    average 1 frag/min better than
    player with 200ms ping
  - "Well, *duh*?"
Concluding thoughts....

Learn anything useful?

- Players will tend to self-select servers within 200ms 'radius'
  - Two servers (separated by 147ms, distinct timezones and regional player populations) appear to validate this conclusion
  - Caveat: server ping estimates are only approximates
- Helps identify potential player population relative to server(s)

Why is Jitter missing?

- Testbed's ping sampling too coarse (10+ samples/minute)
- Lacked resources to deploy revised sampling method (20+ samples/second)
- Jitter impact may be significant (hand-eye co-ordination adapts better to constant latency)

Looking forward....

- Move to Half-Life or CounterStrike, dump QuakeIII
- Instrument servers to track packet loss and jitter
- No resources: I need multiple sites to host new servers with more accurate ping sampling